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DEEMS

SYSTEMATIC URINARY ANALYSIS

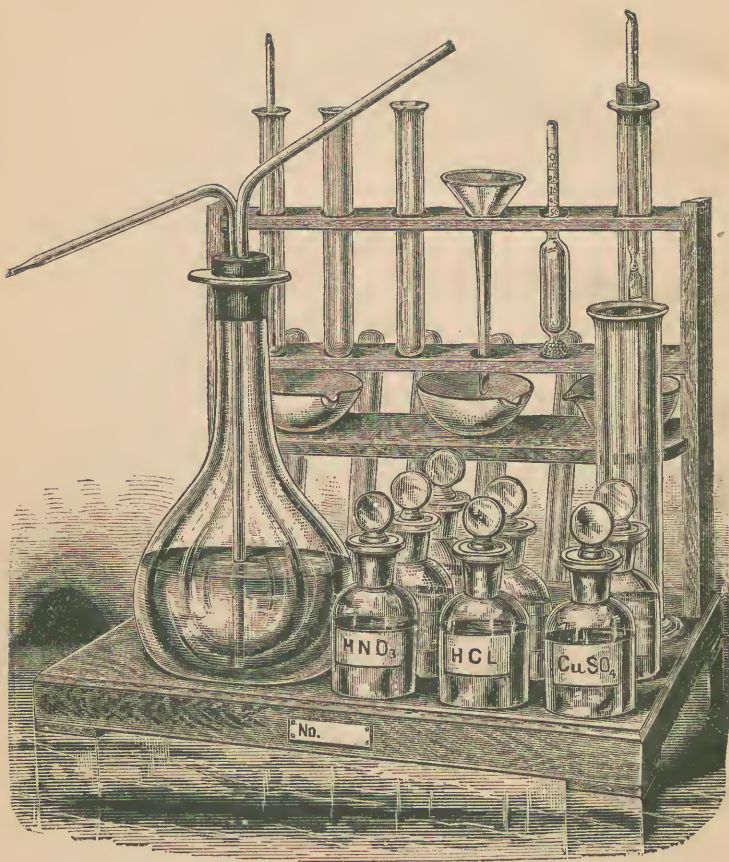
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URINARY ANALYSIS SET. After Prof. Draper.

(For Description see last page.)

HANDBOOK

OF SYSTEMATIC

URINARY ANALYSIS

CHEMICAL AND MICROSCOPICAL.

FOR THE USE OF PHYSICIANS, MEDICAL STUDENTS,
AND CLINICAL ASSISTANTS,

BY

FRANK M. DEEMS, M.D.,

1884

LABORATORY INSTRUCTOR IN THE MEDICAL DEPARTMENT OF THE UNIVERSITY OF NEW YORK; MEMBER OF THE N. Y. COUNTY MEDICAL SOCIETY; MEMBER OF THE N. Y. MICROSCOPICAL SOCIETY, ETC.



NEW YORK:
THE INDUSTRIAL PUBLICATION COMPANY.

1880.

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Film No. 5392, no. 4

PREFACE.

THE following plan or method for the systematic examination of the urine, step by step, both chemically and microscopically, is compiled with the intention of supplying students of medicine, clinical assistants, and busy practitioners with a concise guide, which, from its small compass and tabulated arrangement, will serve both as a bedside reference-book and a work-table companion. While it cannot pretend to take the place of larger works upon the highly important subject of urinary analysis, the compiler hopes, from his somewhat extended experience as a teacher of this branch of physical diagnosis, that it will serve to lessen the difficulties in the way of the beginner, and save time to the busy practitioner in his routine examinations.

429 West Twenty-Second Street,

New York, October, 1, 1880.



HANDBOOK OF URINARY ANALYSIS.

Selection of a Specimen for Examination.

If possible, obtain for examination a specimen from the whole quantity of urine passed in the twenty-four hours, which has been collected and mixed, since the specific gravity and reaction vary considerably at different times during the twenty-four hours. If, as is generally the case, we wish merely to ascertain the presence or absence of any particular substance, such, for example, as albumen, or sugar, the urine passed at any time of the day will in general suffice. But even in such cases, to render the observation of more value, it is better to employ the urine of digestion (*Urina cibi*), and that passed three or four hours after dinner is the best, since this invariably contains the greatest amount of any foreign substances, if such be present. Next to this it is better to take the urine first passed after rising in the morning (*urina sanguinis*). The urine may be received in a perfectly clean half-gallon magnesia jar, covered so as to exclude extraneous matters. *Examine, if possible, within three hours after being voided*, and in all cases before decomposition has begun. When received, a portion of the urine (about 4 or 5 ounces) should be poured into a tall, narrow, cylindrical glass vessel. A graduated test-

tube, provided with a foot or base, is best, since it, at the same time, approximatively measures the bulk of any deposit that may fall. The cylindrical vessels have the advantage over conical ones of having no sloping slides upon which the sediment may collect, and be thus prevented from falling to the bottom. Cover the vessel carefully to exclude dust, and set it aside, whether there be a visible sediment or not. Examine it microscopically after a few hours. Re-examine it after the lapse of twelve hours, by which time any sediment that is likely to fall will have subsided. While this portion is taking care of itself, divide the remaining urine into several parts, filtering them, if necessary, and examine them chemically according to the following tabulated scheme:

Systematic Qualitative Analysis of the Urine.

SECTION I.—GENERAL.

1. Color of the Urine.

- | | | | | | | | | | | | |
|--|---|--|---|---|---|--|---|--|------------------------------------|---|---|
| 1. Normal colors. | { | Pale urine; colorless to straw-yellow.
Ordinary urine; golden-yellow to amber.
Highly colored; reddish-yellow to brown. | | | | | | | | | |
| 2. Abnormal colors. | { | <table border="0"> <tr> <td><i>Essential</i>; arising in the interior of the body.</td> <td>{</td> <td>Coloring matter of the blood.
Biliary Pigment, Urohæmatin, Uroerythrin, Indican.</td> </tr> <tr> <td><i>Accidental</i>; derived from without, and only passing through the organism.</td> <td>{</td> <td> <table border="0"> <tr> <td>Various coloring matters, as e. g.</td> <td>{</td> <td>Santonin, Saffron, Gamboge, Senna, Rhubarb, Aloes, Logwood, Gallic Acid, Creosote, etc.</td> </tr> </table> </td> </tr> </table> | <i>Essential</i> ; arising in the interior of the body. | { | Coloring matter of the blood.
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2. Odor.

- | | | | | | | | | | | | |
|------------------------|---|----------------|---|--|------------|---|-----------|------------|---|----------------|------------------------|
| 1. Essential. | { | Normal. | { | <i>Sui generis</i> . | | | | | | | |
| | | Abnormal. | { | <table border="0"> <tr> <td>Whey-like.</td> <td>{</td> <td>Diabetes.</td> </tr> <tr> <td>Ammoniacal</td> <td>{</td> <td>Decomposition.</td> </tr> <tr> <td>Sulphuretted Hydrogen.</td> <td>{</td> <td>Decomposition.</td> </tr> </table> | Whey-like. | { | Diabetes. | Ammoniacal | { | Decomposition. | Sulphuretted Hydrogen. |
| Whey-like. | { | Diabetes. | | | | | | | | | |
| Ammoniacal | { | Decomposition. | | | | | | | | | |
| Sulphuretted Hydrogen. | { | Decomposition. | | | | | | | | | |
-
- | | | | | |
|--|---|---------------------|---|---|
| 2. Accidental, from odoriferous substances introduced into the organism. | { | Very much varied by | { | Asparagus, Garlic, Oil of Turpentine, Cubebs, Copaiba, Sandalwood Oil, etc. |
|--|---|---------------------|---|---|

6. Quantity.

From 40 to 60 fluid ounces (900 c.c. to 1500 c.c.) in the 24 hours.

7. Detection of Abnormal Substances in the Urine.

Divide the urine into several portions, in which search successively for the following substances: {

- Excess of Urea.* See Section II.
- Albumen.* See Section III.
- Sugar.* See Section IV.
- Bile.* See Section V.
- Blood.* See Section VI.
- Chyle.* See Section VII.

8. Examination of the Sediments.

Chemically.—See page 13. Microscopically.—See page 20.

SECTION II.—UREA, $(N H_2)_2 C O$.—EXCESS AND DEFICIENCY.

1.

Reaction of urine variable; color normal, specific gravity *over* 1030° (if excess be present). Owing to its exceeding solubility, urea never forms a spontaneous deposit. A healthy man excretes from 300 to 600 grains in the 24 hours.

2. Test for Excess.

Take from the fresh-mixed urine of the 24 hours, about an inch in a test-tube. Add to it one-third its volume of pure *colorless nitric acid*, and set the tube in water not warmer than 60° F. It is best to work at the fixed temperature of 33° F., which is readily obtained by melting ice in water. {

- If crystals of *Nitrate of Urea* form immediately, or within a few moments, *urea is present in excess of the normal proportion.*
- Nitrate of Urea* shows flat, rhombic, or hexagonal plates, closely united to one another. Colorless.

3. Test for Deficiency.

Take a sample of the same urine, evaporate over a water-bath to one-half its bulk at a low temperature, allow it to cool, add *nitric acid* as before, and set the tube in water at 60° F., or better, in water containing ice. {

- Crystals of *Urea Nitrate* do *not* form within a few moments, say five minutes. *Urea is below the normal proportion.*

NOTE.—The quantity of urine passed in twenty-four hours must be taken into consideration, for if the patient is passing, instead of the normal 1500 c.c., say only 600 c.c., the urine should be diluted up to 1500 c.c. for test No. 2, and used *without evaporation* for test No. 3. If, on the other hand, the patient is diabetic, and is passing 3000 c.c. per twenty-four hours, a given sample of his urine must be reduced to one-half by evaporation for test No. 2, and a portion of this reduced urine still further reduced one-half for test No. 3.

SECTION III.—ALBUMEN.

Normal Urine ought never to contain Albumen.

1.

a. The urine is turbid and sedimentary. { See 2.

b. The urine is clear and transparent. { See 2 *b.*

2.

Filter or decant.	{	<i>a.</i> The <i>sediment</i> must be examined under the microscope for casts, epithelia, pus corpuscles, etc.					
		<i>b.</i> The filtered urine is	<table border="0"> <tr> <td>{</td> <td><i>c.</i> Acid or Neutral.</td> <td>{ See 3, Test.</td> </tr> <tr> <td>{</td> <td><i>d.</i> Alkaline.</td> <td>{ Neutralize with nitric acid, and see 3, Test.</td> </tr> </table>	{	<i>c.</i> Acid or Neutral.	{ See 3, Test.	{
{	<i>c.</i> Acid or Neutral.	{ See 3, Test.					
{	<i>d.</i> Alkaline.	{ Neutralize with nitric acid, and see 3, Test.					

3. Test.

<i>G.</i> Pour 1 c.c. of <i>nitric acid</i> into 10 c.c. (1 to 10) of urine in a test-tube.	{	<i>a.</i> Coagulation takes place. It is probably due to	{ <i>Albumen.</i> See <i>b.</i>
		<i>b.</i> There is doubt; the liquid is only turbid, or there is but a slight precipitate.	{ See <i>H.</i>

<i>H.</i> Heat the urine.	{	<i>c.</i> The whole is redissolved.	{ <i>Uric Acid.</i> <i>Nitrate of Urea.</i>
		<i>d.</i> The turbidity or precipitate remains.	{ <i>Albumen.</i> See <i>I.</i>

<i>I.</i> Add a small quantity of <i>alcohol</i> .	{	<i>e.</i> Turbidity disappears.	{ Resins. { Cubebs, copaiba, sandal-wood oil, turpentine, etc.
		<i>f.</i> Turbidity remains.	{ <i>Albumen.</i>

4.

The following is a rough but useful *approximate quantity test*: Boil a given quantity of the urine in a graduated test-tube, with a drop or two of *acetic acid*; add *nitric acid*, and set aside for at least twelve hours. The precipitated albumen sinks, and forms a layer of varying thickness. The proportion of albumen is estimated by the depth of this layer, as compared with the height of the column of urine in the tube; and may be expressed in numbers as $\frac{1}{2}$, $\frac{1}{4}$, 1-12. If too little albumen is present to form a layer, the proportion may be loosely expressed as a "cloudiness," or "opalescence." Greater accuracy is obtained by previously filtering the urine of urates, epithelium, or extraneous matter, which might unduly increase the bulk of the deposit on standing.

SECTION IV.—SUGAR, $(C_6 H_{12} O_6) + H_2 O$.—GLYCOSURIA.—DIABETES MELLITUS.

1.

The essential features of the urine in diabetes are its *excessive quantity* and the *presence of sugar* (glucose). The daily *quantity* of the urine in diabetes oscillates usually between 128 and 230 fluid ounces (8 to 15 pints). It has been known to exceed 32 pints. When the excretion is considerable (exceeding 4 or 5 pints), the urine has a very *pale straw tint*, and a peculiarly bright aspect; a less quantity does not alter the natural general appearance. The proportion of sugar varies from 8 to 12 per cent.; the quantity excreted daily ranges from 15 to 25 ounces (may fall to an ounce or less; may rise to two pounds or more). The specific gravity of diabetic urine usually fluctuates a few degrees above, or below 1040^0 ; it may rise to 1060^0 , or sink to 1015^0 . *The sp. gr. is no criterion of the amount of sugar present*, since coexistent *excess of urea* may cause a high density with little sugar, and *albuminuria* may cause comparatively low density with much sugar. If the quantity of sugar be large, a sweetish whey-like odor and taste are communicated to the urine. *Sediments are rarely observed in diabetic urine.*

2.

The cold urine, filtered or decanted, is *not* albuminous. { See 9.

3

The cold urine *contains albumen*. { See 7.

4.

The urine contains bile pigment, or is otherwise high colored. { See 8.

5.

The urine is acid or neutral (diabetic urine is usually acid). { See 9.

6.

The urine has an alkaline reaction due to *ammoniacal salts*. This interferes with the copper tests. { Boil some of the urine in a test-tube, with a small piece of *caustic soda* or *potash*; filter or decant. { See 9.
So—

7.

Add a few drops of *acetic acid* to the urine; boil to coagulate the albumen, filter, neutralize the filtered urine with a little *sodium carbonate*, then test { See 9.
as per—

8.

To *decolorize* the urine, put an ounce or two in an eight-ounce bottle, together with a tablespoonful of *animal charcoal*, and a small pinch of *sodium carbonate*. Shake well for five or ten minutes, and then filter { See 9.
A perfectly colorless liquid will thus be obtained, and greatly facilitate the application of the copper tests.

9. Test (Trommer's).

Add to a drachm of the suspected urine, in a test-tube, about five drops of a solution of *cupric sulphate* (10 grs. to the fluid ounce); then add of *caustic potash solution* (20 or 30 per cent. of strength) an *excess*—i.e., until the *precipitate* of the blue hydrated protoxide of copper is *completely dissolved*. Boil the *clear blue solution* (blue or black precipitate; no sugar). A *yellow or red* (suboxide of copper) precipitate. } *Sugar.*

NOTE.—Repeat the test once or twice with less of the *copper solution* each time. If the proper proportions have been used, the copper-test possesses both delicacy and certainty.

10. Differential Density Fermentation Test (Roberts.)

This test affords a simple and usually sufficiently accurate quantitative analysis for sugar. Proceed thus: (1) Place four fluid ounces of urine in a twelve-ounce bottle, with a lump of German yeast the size of a chestnut; cork loosely so that the carbonic acid gas may escape, or cover with a slip of glass, and set aside in a warm place, such as the mantel-piece, to ferment. (2) A companion bottle of the same size has put into it the same amount of the same sample of urine, *but no yeast is added*, and it is *tightly corked* and placed beside the fermenting vial. (3) In about 22 hours, *when fermentation has ceased*, the two vials are removed and placed in some cooler part of the room. (4) Two hours thereafter—that is, about 24 hours from the commencement of the experiment—the contents of both bottles are poured separately into cylindrical vessels, and the specific gravity of each taken with the urinometer. (5) The difference between the two specific gravities is thus ascertained, and every degree of “*density lost*” indicates *one grain of sugar per fluid ounce of the urine*—e.g., the sp. gr. of the *unfermented urine* = 1040°; of the *fermented urine* = 1020°; difference 20 degrees = 20 grains of sugar per fluid ounce. If the patient has passed, say, 80 ounces in the 24 hours, then $80 \times 20 = 1600$ grains of sugar excreted in the 24 hours.

SECTION V.—BILIARY MATTERS.

1.

Color of the urine greenish-yellow to dark brown.
Agitation produces a permanent yellow froth.
White filtering (blotting) paper, or linen, stained yellow. } *Bile Pigments present.*

2. Gmelin's Test.

Spread a thin layer of the urine upon a white porcelain surface, and add to it a few drops of *nitroso-nitric acid* (nitric acid containing the lower oxides of nitrogen); that from the cell of a Grove or Bunsen battery answers perfectly. } The drop of acid is tinged with a rapidly varying play of colors (in the following order: green, blue, violet-red, and yellowish), which speedily disappear. The most characteristic and essential color is the green. *Bile Pigments.*

3. Pettenkofer's Test.

Place a small quantity of urine, which has been boiled and filtered, in a porcelain capsule (or watch-glass), and evaporate it *slowly* and gently over a water-bath, or spirit flame, until but a few drops remain; add to this a drop or two of a solution of pure *sulphuric acid* (1 part to 4 parts of distilled water), and then a drop of a saccharine solution (cane sugar 1 part, distilled water 4 parts).

A cherry-red color, rapidly deepening until it becomes a beautiful purple, or dark lake color, appears. Only the purple color is characteristic of the presence of the *Biliary Acids*.

NOTE.—Bile pigments have the property of adhering to sediments much more powerfully than other pigments, and may be detected in the sediment when not in the urine itself.

SECTION VI.—BLOOD.

A. On Cooling, the Urine Has a Blood-red Color.

- | | | | | | | |
|-----------------------------|---|--|---|--|---|--|
| 1. It is transparent. | { | a. Add a few drops of <i>Hydrochloric Acid</i> . | { | 1. The color becomes darker. | { | <i>Coloring matters of the blood. See B.</i> |
| | | | | 2. The color becomes clearer. | | |
| 2. It is slightly turbid. | { | b. Allow it to rest until a precipitate forms, which examine | { | { According to 3. | | |
| 3. There is a red sediment. | | { | | c. Observe, under the microscope, whether this precipitate is crystalline or amorphous; on heating it in a test-tube it becomes dissolved. | { | { <i>Urates.</i>
<i>Uric acid.</i> |
| | d. The microscope shows blood corpuscles; the precipitate is not soluble by heat. | | { | { <i>Blood.</i> | | |

B. On Cooling, the Urine is Reddish-brown, "Smoky," or Ink-black.

- | | | | | | |
|---|---|--|---|---|--|
| 4. There is no sediment, and the microscope shows no blood corpuscles. <i>Boil the urine alone, or with a little acetic acid.</i> | { | e. A reddish-brown or dirty <i>coagulum</i> forms. | { | { <i>Coloring matters of the blood. Hæmoglobin and products of its decomposition.</i> | |
| | | | | | |

SECTION VII.—CHYLE.

1.

Reaction varies; sp. gr. varies; color milky, turbid, opaque (rose-colored, if blood be present). Consistence sometimes jelly-like.

2. Test.

- a.* Add to about *three inches* of urine in a test-tube, about *an inch* of *sulphuric ether*. *Gently* mix them. The urine assumes its natural color and transparency. The { Fat is present, and has been dissolved by the Ether. See 3, *b*.

3.

- b.* Transfer a little of the Ether (floating on the urine), by means of a pipette, to a watch-glass (or slide), and allow it to evaporate. { A characteristic stain of fat remains on the glass or slide. *Chyle*.

Systematic Chemical Examination of Inorganic Urinary Deposits.

NOTE.—A portion of the specimen of urine that has been set aside in a cylindrical or conical vessel, has let fall a sediment. The first step consists in completely separating the deposit, which it is desired to examine, by *filtration*. The sediment remaining upon the filter, whatever be its character, must then be washed with a little distilled water. The various tests will be found under the following sections:

SECTION I.—URIC ACID ($C^5 H^4 N^4 O^3$).

1. General Appearance of Urine and Deposit.

Urine depositing uric acid has usually a rich yellow or orange color, and *invariably an acid reaction*. The uric acid crystals may form a film on the surface of the liquid, or lie scattered as brilliant brown specks on the sides of the glass, or subside into a dense red deposit (like cayenne pepper). In rare instances the crystals are so small as to require the microscope for their detection. Generally, however, the naked eye can identify uric acid with certainty, because no other *brown crystals* occur in urine as a spontaneous deposit. When the crystals are very minute, the deposit resembles the amorphous urate, but is *denser*, and sinks more rapidly. Uric acid is usually accompanied by a considerable sediment of urates. A healthy man excretes, on an average, about 7 or 8 grains of uric acid in the twenty-four hours.

2. Calcination at a Red Heat (on Platinum Spoon.)

No residue; gives off ammoniacal odor.

A light black porous coal, containing nitrogen, is sometimes left.

3. Solubility.

- a.* Insoluble in cold water (15,000 parts); slightly soluble in boiling water (1800 parts).
b. Insoluble in all *dilute* acids; alcohol; ether.
c. Soluble in caustic alkalis, carbonates of potash and soda, borax, acid phosphate of soda, from which, if a slight excess of an acid be added, crystals are re-precipitated.
d. Soluble in *strong* sulphuric acid, without undergoing decomposition.

4. Action of Alkalies.

Triturated with caustic alkalies, unctuous compounds are formed, and *ammonia is not set free.*

5. Action of Concentrated Nitric Acid.

Dissolves *with effervescence* and forms a crystalline mass. { See 6.

Explanation of the reaction.	{	Uric acid is decomposed into	{	<i>Alloxan</i> , which forms the crystalline mass, and
				<i>Urea</i> .
{	{	Nitric acid is decomposed into	{	<i>Nitrous acid</i> , which, with <i>Urea</i> , give <i>Carbonic acid</i> and <i>Nitrogen</i> .

Causes of errors.	{	<i>Urates.</i>	{	Dissolve equally with effervescence, as well as calcined ammonio-magnesian phosphates. (<i>Beale</i> .)
		<i>Carbonates.</i>		

6. Murexide Test.

Upon heating this mass, and slowly evaporating it to dryness, a *red residue* remains, which, treated with a few drops of *ammonia* (or caustic potash), becomes purple, or violet-red (murexide or purpurate of ammonia or potash). If potash has been used, the violet color disappears under heat. Caffein gives the same reaction.

7. Nitrate of Silver Test. (Schiff's.)

Dissolve traces of uric acid in *Carbonate of Soda*. With this solution touch, lightly, a paper upon which a drop of *Nitrate of Silver* has been allowed to spread. A dark spot (reduced nitrate of silver) is produced. Will detect from 1-1000 to 1-500,000 of *Uric acid*.

8. Approximate Estimation of the Quantity.

To 30 fluid ounces of urine add 3 fluid drachms of *Hydrochloric acid*, and set aside in a cool place, as a cellar, for 24 hours. At the end of that time the uric acid crystals, highly colored, will be found adhering to the sides and bottom of the vessel. Collect them on a filter. By using always the same quantities of urine and acid, a rough estimate may be made.

SECTION II.—AMORPHOUS URATES. (*Lithates*.)

1. Naked-Eye Appearance.

The "amorphous urates" occur usually in *acid* urine, of a high density (1027), as a bulky, loose pulverulent deposit, wholly devoid of *crystallization*. Its color (varying extremely in tint and intensity, but always deeper than the urine from which it falls) may be fawn, orange, "brick-red," pink, or purplish. It usually sinks quickly and completely, except where the urine is *albuminous*, in which case the precipitate may continue a long while diffused throughout the urine, giving to it a milky appearance. It is the most common and least important of all the urinary sediments. Urine containing an excess of urates is never turbid when freshly passed; it is only when the urine *has cooled* that the peculiar muddiness is observed.

2. Shake, and Heat Some of the Urine in a Test-Tube.

- a. The sediment dissolves, but reappears on cooling. } *Amorphous Urates.*
Urate of soda dissolves at about 100° F.
Urate of ammonia dissolves at about 200° F.
- b. There is doubt; filter the boiling urine. } On cooling, the filtrate yields a deposit—*Urates*.
Filter, and apply *murexide* test to some of the deposit on the filter.
- c. Add strong *Acetic acid* to some of the deposit. It dissolves, and recrystallizes as *Uric acid*. } *Urates.*

SECTION III.—OXALATE OF LIME.

1. General Appearance of the Deposit.

Urine depositing oxalate of lime is usually highly colored (dark amber hue), and acid (rarely neutral). The deposit itself is very scanty, colorless, and closely resembles a slight cloud of mucus. It is often conjoined with a deposit of uric acid and the amorphous urates. If freshly-passed urine be allowed to deposit oxalate of lime in a glass vessel, its sides will be traversed by very numerous fine lines, running in bands, transversely or obliquely, looking as if the glass were finely scratched. The sediment consists of two parts—a soft, pale-grey, mucus-like layer on the bottom of the vessel, and overlying this a snow-white denser layer, with an undulating but sharply defined surface. The form of the crystals of oxalate of lime is so characteristic, that there is seldom occasion to make use of *chemical* tests to determine them. They are too minute to be distinguished by the naked eye. Next to urates, oxalate of lime is the most common unorganized urinary sediment.

2. Solubility.

Soluble (readily) in { Mineral acids, *without effervescence*; also in acid phosphate
of soda.

Insoluble in { Water, alcohol, ether, alkalis, vegetable acids. Distinguished from the
phosphates by its *insolubility* in *Acetic acid*.

SECTION IV.—PHOSPHATES.

The phosphates are only separated from very feebly acid, or alkaline urine, and they are always deposited when the urine undergoes the alkaline fermentation.

1.

The urine is turbid or sedimentary. Divide into two portions, *a* and *b*.

$\left\{ \begin{array}{l} a. \text{ add a few drops} \\ \text{of any acid.} \end{array} \right.$	$\left\{ \begin{array}{l} \text{It clears } \{ \text{Earthy Phosphates.} \\ \\ \end{array} \right.$
$\left\{ \begin{array}{l} b. \text{ Filter or decant} \\ \text{and} \end{array} \right.$	$\left\{ \begin{array}{l} \text{See 3.} \end{array} \right.$

2.

The urine has been recently passed, and is clear and limpid. Boil. { A precipitate is formed which { *Phosphates*.
is soluble in acids.

3.

Add an excess of ammonia to the urine under investigation, agitate, and then allow to rest. { *Earthy* phosphates are precipitated.
Acids dissolve them. See 4, *A*.
{ *Alkaline* phosphates remain in solution.
See 6, *B*.

4. *A*—Earthy Phosphates.

Filter, or decant, throw upon the precipitate <i>Acetic acid q. s.</i> to completely dissolve it.	{ Neutralize with a few drops of <i>Ammonia</i> , then add a little <i>Ammonium chloride</i> .	{ Then add slowly and in excess, <i>Oxalate of Ammonia</i> .	{ A precipitate falls. <i>Oxalate of Lime</i> . Examine it microscopically.
			{ <i>Ammonio-magnesian phosphate</i> remains in solution; decant, or filter, and see 6, <i>B</i> .

5.

Add an excess of <i>Ammonia</i> to the decanted or filtered urine.	1. A precipitate.	{ <i>Ammonio-magnesian phosphate</i> (recognize under the microscope); soluble in acids, insoluble in water and alkaline solutions.
	2. No precipitate.	{ Leave a little of the urine in a closed test-tube for twenty-four hours. If there be no precipitate, there is no <i>Phosphate of Magnesia</i> in the urine.

6. *B*—Alkaline Phosphates.

Divide the urine into two portions. Acidulate <i>a</i> with <i>Nitric acid</i> .	{ Add an equal volume of <i>Molybdate of Ammonia</i> .	A yellow precipitate.	{ <i>Phosphoric acid</i> , in the state of phospho-molybdate of ammonia, insoluble in acids, soluble in alkalies.
		No immediate precipitate.	{ There are only traces of phosphoric acid. Heat mixture to about 104° F.

From <i>b</i> drive off the ammonia by boiling, then separate the urine into two parts.	{ Add alcoholic solution of <i>Bichloride of Platinum</i> .	{ A precipitate.	{ <i>Potassa</i> , in the state of chloro-platinate; beautiful yellow octahedral crystals.
	{ Add solution of <i>bi-meta-antimoniate of potassa</i> .		

SECTION V.—CYSTINE ($C_3H_7NSO_3$).

1. General Appearance.

Very rare urinary sediment. A copious, light sediment (resembling fawn-colored urates), deposited from a urine weakly acid (or alkaline), of a yellowish-green color; oily appearance; peculiar sweetbriar odor (when fresh); very liable to decomposition (evolving ammonia and sulphureted hydrogen), and liable to be accompanied by ammonio-magnesian phosphates, mucus, and epithelia.

2. Solubility.

- | | | | |
|-----------------|---|--|---|
| 1. Soluble in | { | Ammonia. | { Beautiful six-sided <i>colorless</i> crystals reappearing when the volatile alkali has evaporated. They polarize light. |
| | | Caustic alkalies. | { Boiled with <i>Caustic Potash</i> , cystine yields ammonia and an inflammable gas. |
| | | Mineral acids. | { Forming crystalline compounds. |
| | | Oxalic acid. | |
| 2. Insoluble in | { | Acetic acid. | { Precipitates it from its <i>alkaline</i> solutions, amor- phously, or in imperfectly formed crystals, |
| | | Ammonium carbonate. | { Precipitates it from its <i>acid</i> solutions. |
| | | Water, alcohol, vegetable acids (except oxalic). | |

3. Heated on Platinum Foil.

Burns in the air with a bluish-green flame, evolving thick white fumes, having a peculiar, offensive, acid, garlic-like odor, leaving a spongy charcoal, and staining the platinum a dark greenish-blue color, *which disappears under further heating*.

SECTION VI.—LEUCIN.

Very rare deposit in the Urine.

Pure Leucin is a white *non-crystallizable*, odorless, and tasteless organic, fatty-looking substance. If the urine be suspected to contain it, see 1.

1.

Evaporate slowly an ounce or two of the urine to the consistence of a syrup, and set aside to cool. Leucin, if present, appears as circular, oily-looking, dark-yellow, laminated discs, or spheres, *which float upon water*.

2. Solubility.

Soluble in	{	Boiling water, <i>very</i> ; alcohol, <i>sparingly</i> . Strong acids.
		Strong alkalies. { Dissolved in ammonia it remains unchanged, and yields larger spherules when the ammonia spontaneously evaporates.
Insoluble in	{	Ether. { This distinguishes it from <i>fatty matter</i> , which it so much resembles. From crystals of <i>Carbonate of Lime</i> , Leucin may be determined by <i>floating on water</i> —the lime crystals sink.

3. Test.

Put a small quantity of Leucin on a platinum spatula, add *Nitric acid*, evaporate carefully to dryness. Treat the residue with a few drops of *Caustic Soda* solution, which dissolves it. Gently heat to concentrate; an oily-looking drop is formed, which can readily be rolled about under the spatula, neither moistening nor adhering to it. (*Scherer*.)

NOTE.—As Leucin can rarely be had from the urine in sufficient quantity to apply this characteristic test, we have to rely entirely upon its *microscopic* characters.

SECTION VII.—TYROSIN ($C_9H_{11}NO_3$).

Very rare deposit in the Urine.

1. General Appearance.

Greenish-yellow *crystalline* sediment, increasing considerably in bulk with slight evaporation of the urine.

2. To Obtain It.

In doubtful cases concentrate the urine, as recommended in the case of Leucin.

3. Test.

Boil the suspected deposit in an excess of water, and while boiling it add a few drops of a solution of *Nitrate of the Protoxide of Mercury* (nearly neutral); if Tyrosin be present, a red precipitate will go down, while the supernatant liquid will be colored rose or purple-red. (*Hoffmann*.)

4. Solubility.

Soluble in { Acids, alkalies, and boiling water.

Insoluble in { Ether, alcohol, and cold water.

5. Calcination.

Emits, when burned, a disagreeable burnt-horn odor, and does not sublime.

Examination of Urinary Calculi.*(After Witthaus.)*

1. Heat a portion to redness on platinum foil:
 - a.* It is entirely volatile. See - - - - 2
 - b.* A residue remains. See - - - - 5
2. Moisten a portion with $\text{N O}_3 \text{ H}$, evaporate nearly to dryness, add $(\text{N H}_4) \text{ H O}$:
 - a.* A red color is produced. See - - - - 3
 - b.* No red color. See - - - - 4
3. Treat a portion with K H O , without heating:
 - a.* An ammoniacal odor is observed. - *Ammonium urate.*
 - b.* No ammoniacal odor, - - - - *Uric acid.*
4. *a.* The $\text{N O}_3 \text{ H}$ solution becomes yellow on evaporation; the yellow residue becomes reddish-yellow on the addition of K H O , and, on heating with K H O , violet-red, - - - - *Xanthin.*
b. The $\text{N O}_3 \text{ H}$ solution becomes dark brown on evaporation, - - - - *Cystine.*
5. Treat as in 2 :
 - a.* A red color is produced. See - - - - 6
 - b.* No red color. See - - - - 9
6. Heat before the blow-pipe on platinum foil:
 - a.* Fuses, - - - - 7
 - b.* Does not fuse, - - - - 8
7. *a.* Colors the flame yellow, - - - - *Sodium urate.*
b. Colors the flame violet, - - - - *Potassium urate.*

8. The residue from 6 :
- Dissolves in dilute H Cl with effervescence ; the solution forms a white ppt. with ammonium oxalate, - - - - - *Calcium urate.*
 - Dissolves with slight effervescence in dilute $\text{SO}_4 \text{H}_2$; the solution neutralized with $(\text{N H}_4) \text{H O}$, gives a white precipitate with $\text{P O}_4 \text{H Na}_2$,
Magnesium urate.
9. Treat as in 6 :
- It fuses, - - - - - *Ammonio-magnesian phosphate.*
 - It does not fuse, - - - - - 10
10. The residue from 6, when moistened with water, is :
- Alkaline, - - - - - 11
 - Not alkaline, - - - - - *Tricalcic phosphate.*
11. The original substance dissolves in H Cl :
- With effervescence, - - - - - *Calcium carbonate.*
 - Without effervescence, - - - - - *Calcium oxalate.*



Systematic Microscopical Examination of Urinary Deposits.

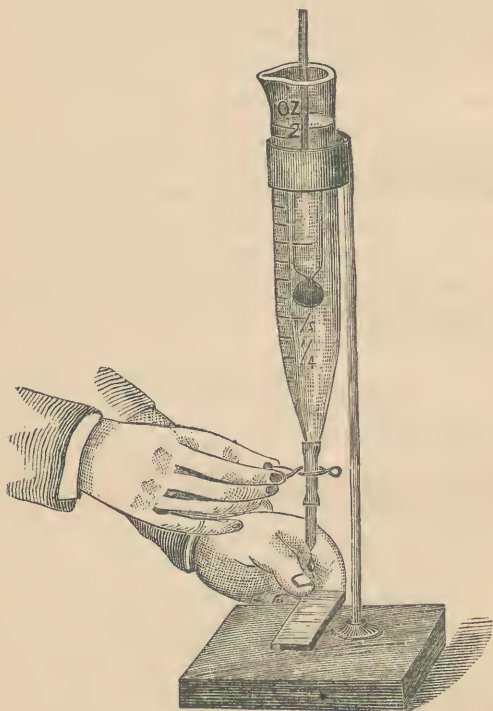
REMOVAL OF THE DEPOSIT FROM THE VESSEL CONTAINING IT.

In order to remove the deposit from the lower part of the vessel in which it has subsided, the upper end of the *pipette* (a glass tube with both extremities open, one of which is much smaller than the other, and tapering), is firmly closed by the forefinger, and the tapering extremity carried down to the very bottom of the glass beneath, or at least in contact with,

the layer of sediment there formed. The forefinger should now be raised sufficiently to allow about an inch of the calibre of the tube to be filled with the sediment, when the upper aperture is to be again tightly closed, the tube withdrawn, about one-half of its contents allowed to flow out, and the external surface wiped off with a piece of new linen or muslin. A certain quantity of the deposit, usually *a single drop*, is now allowed to flow on the glass slide (which has been scrupulously cleaned), or in a shallow cell, by gently raising the forefinger from the top. It is then covered with a thin glass cover, and subjected to examination in the usual way. *Always examine with a lower power first, and then with a higher one.* Any excess of urine which may exude at the margin of the cover, should be removed by bringing in contact with it a piece of filtering or blotting paper, or the ragged edge of a piece of old muslin.

The removal of urinary deposits by means of a pipette is an awkward and unsatisfactory mode of procedure, and several ingenious contrivances have therefore been devised to facilitate their collection and removal. Small glass trays with glass handles have been recommended; the tray is placed at the bottom of the urine-glass, and when the urine has deposited its sediment, the tray is raised by means of the handle, and the sediment examined. In this way, however, the deposit is removed *en masse*, and successive layers cannot conveniently be examined *seriatim*. To obviate these difficulties, an improved and exceedingly simple form of urine-glass, for the collection and examination of deposits, has been contrived, by which minute quantities of sediment can be withdrawn for the purpose of microscopic examination. The arrangement consists of a slight modification of Mohr's burette; this is shortened and widened, forming a conical cylinder of sufficient capacity to hold two ounces of urine, and width to allow a urinometer

to float freely. The sediment is drawn off by means of a glass jet inserted into a piece of india-rubber tubing, which is attached to the neck of the urine-glass. The flow is broken



by a spring pinch-cock, which, by compressing the tubing between the neck of the urine-glass and the jet, effectually prevents leakage. On pressing the pinch-cock the compression is removable, and a flow occurs. Three or four pieces of

india-rubber tubing fitted with glass jets are supplied with each instrument, and these when not in use are to be kept in a bottle filled with dilute hydrochloric acid, to prevent their becoming encrusted. The whole instrument, mounted on a black stand with lacquered brass supports, is a neat as well as useful adjunct to the consulting-room table.

Thin shallow cells, made of glass, or gum dammar, or animalcule cages, present certain advantages over plain slides for examining urinary deposits, since in the former a stratum of fluid of any degree of thickness can be very readily obtained. With a plain slide it is almost impossible not to *greatly modify* the microscopic appearance of the deposit by pushing the cover upon the stratum of urine between it and the slide. Blood corpuscles and amorphous matter may, by this movement, be so aggregated together into cylindrical masses as to closely resemble tube-casts, and thus lead to serious error. By using a shallow cell this source of error is avoided.

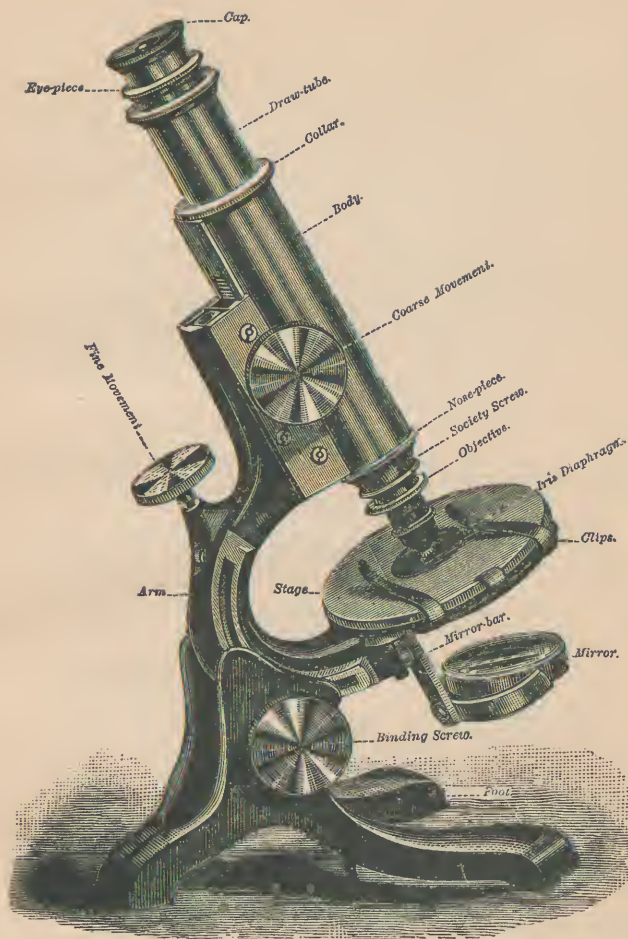
MAGNIFYING POWERS REQUIRED FOR THE EXAMINATION OF URINE.

Urinary sediments require to be examined with different magnifying powers. The objectives which the author would recommend to the student are the two-third inch (giving a magnifying power, with different eye-pieces of from 75 to 150 diameters), and the one-fifth inch (250 to 700 diameters). If the above-mentioned objectives are of really excellent quality, additional magnifying power can be most economically obtained by means of an amplifier, or by using higher eye-pieces. For urinary examinations, magnifying powers of from 200 to 600 diameters will, in general, answer all require-

ments. The purchase, therefore, of a higher power objective than a one-fifth or one-sixth inch may be safely deferred by the student until he shall have become somewhat of an expert in microscopical manipulation. Without any disparagement to the numberless excellent instruments in the market, within the reach of the student of limited means, the author can recommend, from personal experience in its use, the *New Working Microscope*, recently brought out by Mr. George Wale, an illustration of which will be found elsewhere.

THE MICRO-CHEMISTRY OF URINARY DEPOSITS.

In the investigation of those deposits which are prone to assume very various and widely different forms, such, for example, as uric acid, it will often be necessary to apply some simple chemical tests before the nature of the substance under examination can be positively determined. By a little ingenuity and practice, the student may perform under the microscope all the chemical tests described in the foregoing *Systematic Chemical Examination of Inorganic Urinary Deposits*. But *Nitric acid* and *Hydrochloric acid* should never be employed under the microscope, where it can be avoided, as the vapor from these acids rapidly corrodes the metallic mounting of the objective. Whenever they are employed the objective should be promptly and carefully wiped with a piece of fine old linen, or a piece of soft glove leather. In applying reagents, the pointed extremity of some blotting or filtering paper, or a thread, may be inserted between the slide and thin glass cover (or it may be applied closely against the latter), while a drop of the reagent is placed upon the other extremity of the paper at a short distance from the thin cover. The paper, absorbing the fluid by capillarity, establishes a current passing from the point upon which the reagent was



NAMES OF THE DIFFERENT PARTS OF THE MICROSCOPE.

To aid the student in acquiring a familiarity with the microscope, we have inserted a cut in which the names of all the different parts are given in connection with each. The microscope is that known as the New Working Microscope, which, with two eye-pieces, and 2-3 and 1-5 objective, is sold by the Industrial Publication Company for \$35.



deposited, through the paper, to the thin glass. What occurs may then be observed, and the chemical reaction which ensues be investigated. A much more expeditious process consists in treating a small drop of the sediment upon a glass slide, with an excess of the reagent, then cover the whole with the thin glass, and examine the result under the microscope. A companion drop, not so treated, will show by comparison the changes which the reagent has induced. The following tables give the behavior of most urinary deposits when treated with *acetic acid*.

General Micro-Chemical Analysis of Urinary Sediments.

The simplest and, perhaps, best division of urinary deposits is into *unorganized* and *organized*.

A. UNORGANIZED SEDIMENTS.

(a) Crystallized.

- | | |
|--|--|
| <p>1. <i>Acid Urine.</i>
 Uric Acid,
 Oxalate of Calcium,
 Calcium Phosphate (Stellar),
 Cystine,
 Tyrosine.</p> | <p>2. <i>Alkaline Urine.</i>
 Ammonium Urate,
 Triple Phosphate,
 Calcium Phosphate,
 Magnesium Phosphate.
 (Very rare.)</p> |
|--|--|

(b) Amorphous.

- | | |
|--|---|
| <p>Urate of Sodium and Potassium,
 Fats.</p> | <p>Calcium Carbonate,
 Calcium Phosphate.</p> |
|--|---|

SECTION I.—NON-ORGANIZED BODIES.

1. Distinctly Crystalline Bodies.

- | | | | | |
|--|----------------------------------|---|----------------------------------|--|
| <p>Very large <i>transparent</i> crystals with sharply defined edges, generally isolated. Typical form, a triangular prism with beveled edges. Occurs in <i>alkaline</i> urine only. Polarizes light beautifully.</p> | <p style="font-size: 3em;">}</p> | <p><i>Soluble</i> in Acetic acid.</p> | <p style="font-size: 3em;">{</p> | <p><i>Ammonio-magnesian (or Triple) Phosphate.</i></p> |
| <p>Large crystals, often grouped, <i>always colored</i> (in red, yellow, or brown); typical forms, a four-sided rhomb or hexagonal plate; surface often fissured; outlines very dark. Occurs in <i>acid</i> urine only. (Use a power of 100 or 200 diameters.)</p> | <p style="font-size: 3em;">}</p> | <p><i>Insoluble</i> in Acetic acid.</p> | <p style="font-size: 3em;">{</p> | <p><i>Uric acid.</i></p> |

Large crystals, <i>colored</i> , closely resembling ammonio-magnesian phosphate in form, may occur in needles, either separate or combined in stellate groups. Occurs only in <i>acid</i> urine. <i>Very rare deposit.</i> (Use a power of 200 diameters.)	Insoluble in Acetic acid.	Hippuric acid.
Very small crystals (less than 1-1000th of an inch in diameter, usually), isolated; octohedral form (more rarely dumb-bells); very transparent, or of a faint greenish tint; very refractive; sharp edges; require a power of 400 to 600 diameters to show them well.	Insoluble in Acetic acid.	Crystals of Oxalate of Lime.
Irregular, opaque, globular masses, or spherules, with spiny projections (either straight or curved), "hedge-hog" crystals—or prismatic crystals arranged in star-like masses. Comparatively rare spontaneous deposit in the <i>crystalline</i> form. Found in <i>acid</i> and <i>neutral</i> urine.		Urate of Soda.
Crystalline rods, either separate or in stellate groups (rosettes), or sheaf-like bundles. Some of the crystals club, wedge, or bottle shaped, and abundantly marked with lines of secondary crystallization. Frequently associated with oxalate of lime. Not a very common deposit. Found in pale, faintly <i>acid</i> urine, with a tendency to alkaline fermentation.	Soluble in Acetic acid.	Crystalline Calcium. "Stellar" Phosphate.
Regular, colorless, hexagonal tablets; various sizes; united by their flat surfaces, and overlapping one another; may have an iridescent mother-of-pearl lustre; surfaces often marked with lines of secondary crystallization; or (being dimorphous) square prisms, singly or stellate; strongly refracting light. <i>A very rare deposit.</i>	Insoluble in Acetic acid. (Soluble in Ammonia. This differentiates it from Uric acid.)	Cystine.
More or less yellowish-tinged, highly-refractive spheres, having the appearance of fat globules, with sharp contours, and, with good light, showing radii and delicate concentric lines. Found only in grave destructive diseases of the liver.	Insoluble in Ether. (Distinguishes it from Fat.)	Leucin.
Very fine short silky acicular prisms, or needles, arranged in beautiful bundles, tufts, or "sheaf-like" collections or spiculated balls. Usually of a deep yellow color from absorbed bile pigments. Found associated with and under the same circumstances as the preceding body.	Insoluble in moderately strong Acetic acid.	Tyrosin.

2. Amorphous Bodies.

Granules, irregular, opaque; or spherules, from which project spiny crystals, straight or curved; or globules, opaque, isolated, or united in a mass like frogs' eggs.	{ Slowly <i>soluble</i> in Acetic acid, after a short time giving rise to colorless tablets of Uric acid. }	{ <i>Urates.</i> }
Granules, roundish or oval, with dark outlines, isolated, or three or four united in a star-like form, or in beads, etc.		
Granules very pale, much smaller, very transparent, and difficult to perceive; always united by irregular punctated patches (the most common appearance).	{ <i>Soluble</i> in Acetic acid. }	{ <i>Calcium Phosphate.</i> }

SECTION II.—ORGANIZED BODIES.

1. Mucus. 2. Epithelium (from various parts of the genito-urinary tract). 3. Renal Tube Casts. 4. Blood. 5. Pus. 6. Spermatozoa. 7. Fungi. 8. Entozoa.

[NOTE.—Urine voided turbid will, in the majority of cases, owe its turbidity to one or more of the organized deposits.]

1. Cellular, Round, or Oval Bodies.

Circular discs or globules; <i>non-nucleated</i> ; 1-3500th of an inch in diameter; separate; edges smooth or dentated; transparent or of a faintly yellowish color; sometimes presenting a central depression, and, if seen in profile, bi-concave. (Use high power.)	Swell in weak <i>Acetic acid</i> , or shrink and present a "raspberry" aspect. <i>Not colored</i> by carmine.	{ <i>Red Blood Corpuscles.</i>
Globules, round or oval; <i>nucleated</i> ; 1-2000th to 1-1400th of an inch in diameter; slightly defined outlines; single, double, or multiple nuclei; grayish-white or granular contents; isolated, or united in masses of polygonal cells (use 300 to 400 diameters).	Rendered pale by <i>Acetic acid</i> , which causes two or three nuclei to appear within them. <i>Colored</i> by carmine.	
Globules, round, elongated, or oval; very small, varying in diameter from 1-7000th to 1-2500th (average 1-3000) of an inch; transparent, very refractive; larger ones nucleated, or have vacuoles, and sometimes warty expansions. Germinate if set aside several days. United in chains of three and four, or more, or isolated. (Examine with magnifying power of 500 to 600 diameters.)	Unchanged by <i>Acetic acid</i> . Uncolored by carmine. Their protoplasmic cell-contents, but not their sacs, stained brownish-yellow by <i>Iodine-water</i> .	{ <i>Spores of Fungi. (Penicillium Glaucum, etc)</i>

Corpuscles very small (length about 1-3000th of an inch); very refractive; of a peculiar bluish tint, and fatty lustre; furnished with a very delicate, long, (1-250th of an inch) tail-like filament; general appearance of a minute tad-pole, with greatly elongated tail. (Use 400 to 600 diameters.)	Unchanged by the reagents above mentioned.	<i>Spermatozoa</i>
--	--	--------------------

2. Form Variable; Size Greater than the Preceding.

Round, oval, lamellar, cylindrical, fusiform, caudate, or irregular bodies; furnished generally with one or more nuclei, with granular contents.	Rendered pale by <i>Acetic acid</i> , which brings out their nuclei very distinctly. <i>Colored</i> (the nuclei especially) by <i>carmine</i> .	<i>Epithelium</i> from various parts of the Genito-urinary tract.
--	---	---

3. Cylindrical.

<i>A.</i> Voluminous, of greater or less length (rarely exceeding the 1-50th of an inch); variable aspect; pale or hyaline, granular or covered with epithelium; sometimes distinctly, sometimes indistinctly outlined; generally round or club-shaped extremities.		<i>Renal Tube Casts.</i>
<i>a.</i> Very pale or transparent Amorphous cylinders.	With badly defined margins, often twisted or varicose, branching and subdividing. } <i>Uncolored by carmine.</i> With clear, well-defined margins, sometimes intersected by fractures. } <i>Colored by carmine.</i>	<i>Mucus Casts.</i> <i>Hyaline or "waxy casts."</i>
<i>b.</i> More or less dark, epithelial or granular cylinders. (Use power of 200 to 400 diameters.)	No line of contour; epithelial cells united into a cylinder. Never very narrow. } A more or less distinct line of contour; fundamental substance finely granular, studded with blood corpuscles. }	<i>Epithelial or granular casts.</i> <i>Fibrinous blood casts.</i>

Any of the above may undergo fatty degeneration.

<i>B.</i> Very short; very small (1-1000th to 1-3000th of an inch in length) transparent bodies; sometimes motionless, but generally exhibiting active vibratory movements; or two or more joined end to end with a spiral motion. (Requires a power of 500 diameters, and upwards, to show them well.)	Unchanged by <i>Acetic acid</i> , except the arrest of motion. Their protoplasm colored yellow by <i>Iodine-water</i> .	<i>Bacteria.</i>
---	---	------------------

4. Filamentous, or Fibrillary.

Very thin ; more or less ramified or interlacing.	{	<i>Acetic acid</i> does not change them.	{	<i>Thallus of Fungi.</i>
		<i>Acetic acid</i> renders them pale, causes their fibrillary aspect to disappear, and gives rise to a swollen, transparent, amorphous mass.		<i>Fibrin.</i>
		<i>Acetic acid</i> renders them more distinct, and gives them a punctated or striated appearance.		<i>Mucus.</i>

5. Square.

Square bodies, subdivided into secondary squares, which number 2, 4, 8, etc., and when collected in the form of cubes, very much resemble bales of goods.	{	<i>Sarcina.</i>
---	---	-----------------

Form of Recording Urinary Examinations.

(To be printed on a full letter sheet.)

Examination of Urine.

For _____ at the request of

Dr. _____

Physical and Chemical Characters.

Total Quantity in twenty-four hours,

Color and Appearance,

Odor,

Reaction,

Specific Gravity,

Albumen,

Sugar,

Quantity and General Appearance of the Deposit,

Microscopical Appearance.

Crystals,

Anatomical Elements,

Casts,

Other Morphological Elements.

Remarks.

URINARY ANALYSIS SET.

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See Frontispiece.

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1 One-pint Washing-Bottle, with Rubber Stopper.

1 Urinometer.

1 Glass Urinometer Cylinder, with Base or Foot.


1 Porcelain Evaporating Dish, $2\frac{1}{2}$ oz. capacity.

1 Glass Funnel.

2 Watch Glasses.

6 doz. Test Tubes—Rack and Drying Pegs for 9.

1 doz. $4\frac{1}{2}$ oz. Glass-Stoppered Reagent Bottles, for the following reagents: 1. Hydrochloric Acid. 2. Nitric Acid. 3. Nitrous Acid. 4. Sulphuric Acid. 5. Acetic Acid. 6. Potassic Hydrate. 7. Ammonic Hydrate. 8. Sodid Carbonate. 9. Argentic Nitrate. 10. Alcohol. 11. Ether. 12. Cupric Sulphate.

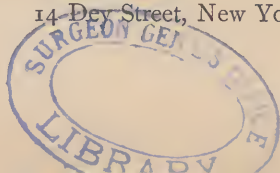
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
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
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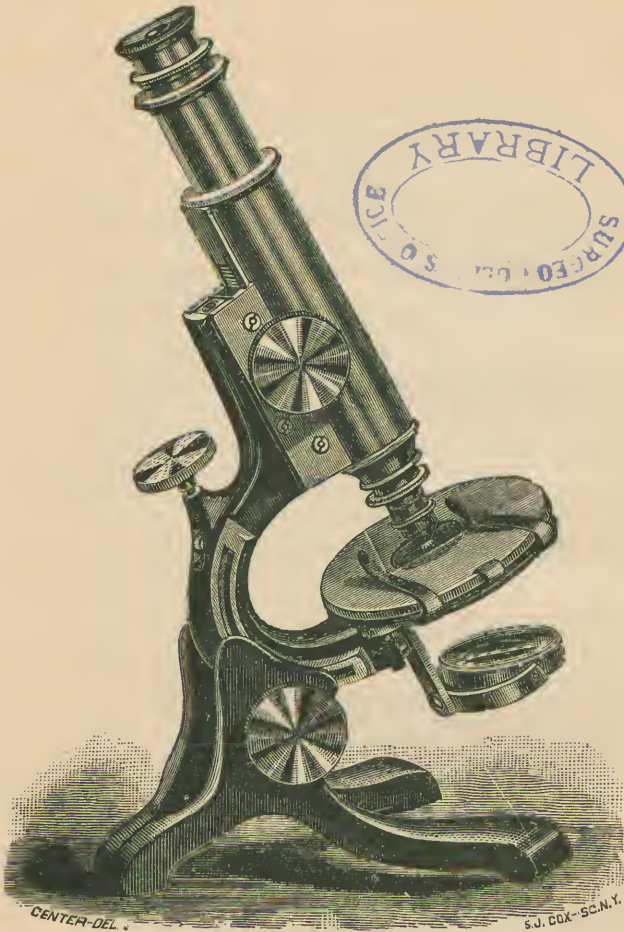
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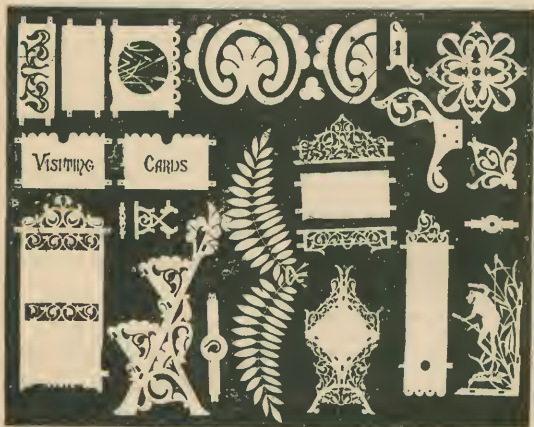
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